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Article

Use of reported speech in the communicative interactions of individuals with ventromedial prefrontal cortex damage

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Abstract

Reported speech (RS) is a pervasive discourse practice in which speakers represent, or re-enact, words, thoughts, or feelings from other times and/or places, and it is thought to reflect and create emotional connections among interlocutors. The current study examines the role of the ventromedial prefrontal cortex (vmPFC), a neural structure critical for social, emotional, and interpersonal behavior, in the use of reported speech. In the communicative interactions of six individuals with vmPFC damage and six healthy comparison participants, each interacting with a clinician, we compared the frequency and use of reported speech. Contrary to our predictions, the vmPFC participants did not differ from healthy participants in the frequency or use of reported speech. These results suggest that the vmPFC does not make critical contributions to the use of reported speech in conversation and furthers our understanding of neural and cognitive underpinnings of reported speech and language use.

KEYWORDS: COMMUNICATION; REPORTED SPEECH; SOCIAL INTERACTION; VENTROMEDIAL PREFRONTAL CORTEX

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Emotion plays a critical role in successful social interaction. Ylvisaker and colleagues argue that 'socially skilled people – people who are liked and have a high degree of social-interactive competence in their chosen social contexts – are people who are able to affect other people positively and with the effect that they intend and who are capable of being affected positively by others the way the others would like to affect them' (Ylvisaker *et al.*, 1998: 271). Tannen (1989) suggests that people affect others in everyday conversations with the pervasive use of 'involvement strategies' (e.g., reported speech, repetition, imagery) that reflect and create emotional connections (i.e., empathy) and interpersonal involvement between interlocutors. Indeed, conversation requires speakers to use social and emotional information to make decisions about how to affect the listener such as what details to represent, what emotional tones to present with different types of information, and what impression to leave with the listener.

Reported speech, one of the involvement strategies identified by Tannen, is a pervasive discourse practice in which speakers represent, or re-enact, words, thoughts, or feelings from other times and/or places (see Hengst *et al.*, 2005; McCarthy, 1998; Tannen, 1989). The use of reported speech in everyday interactions can take diverse structural forms to achieve a range of interactional functions. For example, reported speech can be classified into two canonical forms used primarily for factual representation of past events: direct reports, or direct quotes (e.g., Mary said, 'I'll pick up the dry cleaning') and indirect reports, or paraphrases (e.g., Mary said that she would pick up the dry cleaning). However, reported speech is seldom simply used to report words verbatim. Even on those occasions, the represented words are re-constructed for new purposes to meet the social and interactional demands of the reporting context. Reported speech serves a range of creative and interpretive functions as speakers strategically construct or reconstruct others' thoughts and words (factual or hypothetical) to serve their own purposes (Clark and Gerrig, 1990; Tannen, 1989). For example, speakers use reported speech to represent the thoughts and feelings of others, to state what might have been said (but wasn't) and what will (should or might) be said in the future (Duff *et al.*, 2007; Hengst *et al.*, 2005). Such referring events can also cover a wide range of temporal domains from the remote past to the distant future as well as the here and now.

The current study examines the role of the ventromedial prefrontal cortex (vmPFC) in the use of reported speech in social interaction. The vmPFC is critical for prosocial behavior and producing adaptive interpersonal behavior in response to evolving environmental demands (Damasio, 1996; Mah *et al.*, 2005; Rolls, 1997; Stuss and Levine, 2002). Despite preserved intelligence and memory, damage to the vmPFC can cause significant deficits in social and emotional functioning such as indifference, impaired social judgment and decision-making, diminished generation and interpretation of affective responsiveness, reduced empathy, and deficits in perceiving and responding to verbal and non-verbal social cues (Anderson *et al.*, 1999; Bar-On *et al.*, 2003; Barrash *et al.*, 2000; Bechara and Damasio, 2005; Bechara *et al.*, 2000; Beer *et al.*, 2006; Croft *et al.*, 2010; Damasio, 1994; Eslinger, 1998; Fellows, 2006; Mah *et al.*, 2005; Shamay-Tsoory *et al.*, 2003; Stone *et al.*, 1998; Stuss *et al.*, 2001). While it has been proposed that the vmPFC is involved in the production of socially advantageous behaviors in conversation (Body, 2007; Schumann, 1999), this connection is largely unexplored. An open question is whether the pervasive deficits in social, emotional, and interpersonal behavior following vmPFC damage extend to the use of involvement strategies in the conversations of such patients.

The current investigation is part of a programmatic line of work examining the role of the vmPFC in social interaction and communication (e.g., Gupta *et al.*, 2012; 2014; Kurczek and Duff, 2011). Such studies add to a long history of work linking the frontal lobes to various aspects of language and communication (e.g., Alexander *et al.*, 1989; Shamay-Tsoory *et al.*, 2005; Shammi and Stuss, 1999) and can contribute to our understanding of the social communication deficits observed in other populations such as traumatic brain injury and schizophrenia, where vmPFC pathology is well established (e.g., Adams *et al.*, 1985; Adida *et al.*, 2011). Here we investigate the use of reported speech in the conversational interactions between a clinician and each of six participants with bilateral vmPFC damage. Based on the empirical literature documenting disruptions in social behavior in patients with vmPFC damage and the frequent reports from family members we hear regarding the poor quality of social interactions and interpersonal relationships of these patients, we predicted disruptions in the frequency and use of reported speech in these interactional sessions. In addition to the hallmark disruptions in social and emotional processing, vmPFC damage has been associated with disruptions in future thinking (Fellows and Farah, 2005; Simons *et al.*, 2006), self-referential processing (Craik *et al.*, 1999), and creativity (Flaherty, 2005). Thus, we may also observe group differences in reported speech in type (e.g., use of projected reported speech to refer to hypothetical or imagined events), speaker (e.g., self vs. other) and temporal domain (e.g., future).

Methods

Participants

The six participants with adult-onset vmPFC damage in this study have been extensively characterized in our lab (e.g., Bechara *et al.*, 1994; Croft *et al.*, 2010; Koenigs and Tranel, 2008). While general intelligence, language, and memory are within normal limits on standard neuropsychological measures, these patients present with significant post-morbid disruptions in social-emotional processing (see Table 1). Damage to the vmPFC was defined as the region of the medial sector of the orbital and lower prefrontal cortex (Broadmann areas 10, 11, 12, 24, 25, 32; see Barrash *et al*., 2000). Neurological patients included six (three female) individuals with bilateral, adult-onset vmPFC damage (see Figure 1 for lesion overlap map; Subject 3350 was not included because of difficulty transferring the lesion to a common space). Six healthy community dwelling comparison participants were recruited from the Iowa City community and were matched pair-wise to the patient group on sex, age and education. The healthy comparison participants were free of neurological and psychological conditions per self-report. Mean age and education for the patient group were 63.4 (SD = 8.1) and 13.6 (SD = 2.3) years, respectively, and there were no significant group differences for age = (t (10) = 0.44, p = 0.67) or education = (t (10) = 0.65, p = 0.53). All patients were in the chronic epoch with a mean time post onset of 14.7 (SD = 10.8) years.

Table 1. Demographic and neuropsychological profiles of vmPFC participants.

Subject	Age	Ed	Etiology	FSIQ	WMS GMI	BNT	Token	WCS # Cat.	SIF	APP
318	71	14	Meningioma Resection	143	109	60	44	6	3	Yes (3)
2352	62	14	SaH; ACoA	106	109	54	44	6	2	Yes (3)
2391	65	12	Meningioma Resection	109	132	57	43	6	2	Yes (2)
2577	71	11	SaH; ACoA	84	96	55	44	0	3	Yes (3)
3349	68	12	Meningioma Resection	101	103	53	44	5	1	Yes (1)
3350	59	18	Meningioma Resection	118	108	52	N/A	6	1	Yes (1)
$\bar{x}$ (SD)	66 (4.9)	13.5 (2.5)		110.2 (19.6)	109.5 (12.1)	55.2 (2.9)	43.8 (0.4)	4.8 (2.4)	2.0 (0.89)	2.17 (0.98)

Note: Ed = Education; SaH = Subarachnoid hemorrhage; ACoA = Anterior communicating artery; FSIQ = Full Scale IQ from the Wechsler Adult Intelligence Scale IV; WMS GMI = Wechsler Memory Scale General Memory Index; WMS WMI = Wechsler Memory Scale Working Memory Index; WMS-III, Wechsler Memory Scale III; BNT = Boston Naming Test; Token = Token Test; COWA = Controlled Oral Word Association Test; WCS # Cat. = Wisconsin Card Sort Test, number of categories achieved; SIF = Social and Interpersonal Functioning - The extent of post-lesion change or impairment in aspects of social conduct and interpersonal functioning was rated on a three-point scale by neuropsychologists, with 1 = no change or impairment, 2 = moderate change or impairment, 3 = severe change or impairment; APP = Acquired Personality Problems – Whether or not the participant had acquired problems in personality functioning, as derived from data on the Iowa Rating Scales of Personality Change. The numbers in parentheses denote degree of severity, where 1 = mild, 2 = moderate, and 3 = severe.

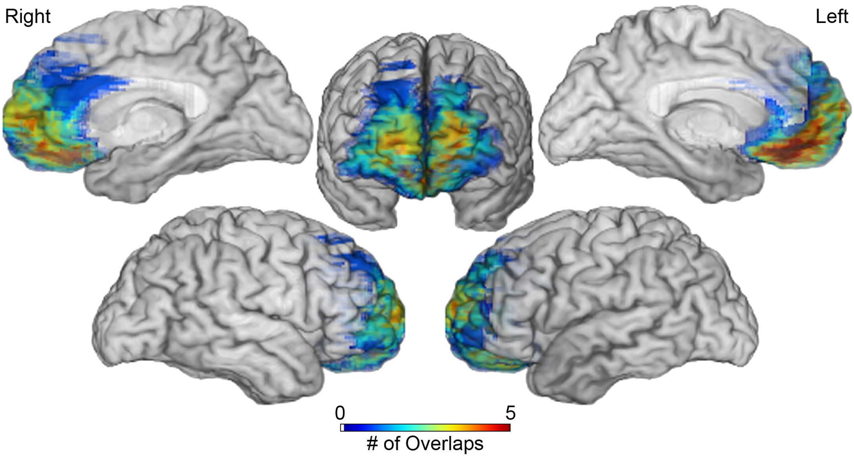

Figure 1. Lesion overlap map of five of the six vmPFC participants

Table 2. Description of reported speech types and temporal domain of reported speech episodes

Type	Description	Example
Direct Reported Speech	Presented as exact words of original speaker; agrees syntactically with reported context	He said, Grandpa, over here.
Indirect Reported Speech	Presented as a paraphrase of the speech being reported; agrees syntactically with the reporting context	She said she saw you there.
Projected Reported Speech	May be case in either direct or indirect forms but represents speech that was not, or has not yet been, said (e.g., to tell someone what they should say; to report what might have been said; to speak for animals or objects that don't speak)	That's what I should have said.
Indexed Report of Speech	Not presented, either directly or indirectly, but simply pointed to, or indexed, often with deictic pronouns or demonstratives	He was telling me about it.
Undecided	Reported speech episode that is not easily categorized into one of the four types above; may be a blended form, contain many linguistic errors, or be abandoned or interpreted before completion	they've put a sign, you know future home of the an' plan

Temporal Domain		
Past	Reported contexts from across the lifespan from childhood up to the beginning of the session	*It happened when I was in college.*
In-Session	Reported contexts from within the data collection session	*That's what I was talking about earlier.*
Future	Reported contexts that were anticipated or forthcoming	*When I have children, I think I'll tell them…*
Undecided	Reported contexts that were vague, ambiguous or not specified	*She tells me that all the time.*

Data collection and transcription

An interactional discourse elicitation protocol (see Hengst and Duff, 2007) was used to structure the session and elicit conversational language across four types of discourse including: (1) conversation; (2) personal narrative (e.g. frightening experience, J.F.K.'s assassination, family story); (3) picture description (cookie theft, Normal Rockwell – *Breaking Home Ties*, World Trade Center on 9/11/2001); (4) procedural (how to prepare a favorite sandwich, how to shop in an American grocery store, how to change a tire). The protocol allowed for collection of videotaped sessions of participants interacting with a female clinician. The clinicians were two women in their mid-20s and while one clinician collected 33% of the data and the other collected 66% there were no differences in the amount of reported speech produced by the two clinicians ($t(6) = 1.46$, $p = 0.22$) in their respective sessions. Clinicians were trained in the administration of the protocol but neither was given instruction to produce or elicit reported speech or knew the study hypotheses. All sessions were audio and video taped and then transcribed by an original and consensus transcriber across three stages (see Duff *et al.*, 2008). Briefly, during the first stage the original transcriber transcribed all utterances, audible sounds, and pause times from the audio portion of the taped interactions. In the second stage, the original transcriber watched the videotape of the sessions and made additions or corrections to the audio content of the transcript. In the third stage, the consensus transcriber and the original transcriber viewed the video together and generated a final version of the transcript – the consensus transcription. Corrections and additions were made through discussion and consensus. Sessions were of similar length and there were no differences in the amount of words produced by the participants ($p = 0.13$) or clinicians ($p = 0.09$) between patient and comparison participants.

We also examined the sessions for differences in verbal productivity, the ratio of the productive words (those that add up to meaningful communication or to structural units) to the number of total words produced (Cherney *et al.*, 1989). Transcripts were edited and the following were removed from final word counts, leaving the remaining words to be included in the productive word counts: (a) exact repetition of words or phrases except when for emphasis (e.g., he was *was* there for five hours); (b) false starts and revisions (e.g, *I can just* you can just feel it); (c) abandoned utterances or phrases (e.g., *because they were just thinking* (pause) they said I was wrong); (d) nonlinguisitic vocalizations (e.g,. *um* going to *uh um* the store); and (e) part word repetitions (e.g., the *book* bookstore). The verbal productivity was similar for vmPFC (91.5) and comparison sessions (93.0) with no significant group differences (t=0.90, p = 0.39).

Analysis

The analysis of RS was conducted on discourse obtained throughout the session, including all task (e.g., personal narrative) and between-task interactions (e.g., small talk between tasks) and included speech produced by both the clinician and the participant. Reported speech episodes were identified following the reported speech analysis procedures used in our previous studies (Duff *et al.*, 2007; Hengst *et al.*, 2005). Using a consensus procedure, we first identified the number of reported speech episodes (RSEs) and then categorized each episode for RS type, temporal domain, speaker, and accuracy.

The five types of reported speech we coded included: direct, presented as exact words of original speaker; agrees syntactically with reported context – e.g., *She'd say well God told us we don't need a new car*; indirect, presented as a paraphrase of the speech being reported; agrees syntactically with the reporting context – e.g., *She called to say that she couldn't get home*; indexed, not presented, either directly or indirectly, but simply pointed to, or indexed, often with deictic pronouns or demonstratives – e.g., *It's just exactly what you said*; projected, may be in either direct or indirect form but represents speech that was not, or has not yet been, said, such as telling someone what they should say, reporting what might have been said, or speaking for animals or objects that don't speak – e.g., *We never told my sister*; *You might … think wow y'know I wanna hurry up;* and undecided, reported speech that is not easily categorized into one of the four types above; may be a blended form, contain many linguistic errors, or be abandoned or interrupted before completion – e.g., *He goes Timbuk- so they started talking about this.*

We coded for the reported context across four temporal domains including: past, reported contexts from any time period across the lifespan up to the beginning of the session – e.g., *They came in an' announced that Martin Luther King had been assassinated*; reported contexts within the testing session, e.g., *I said put the lettuce on top of the ham though*; future, reported contexts that were anticipated or forthcoming – e.g., *The third one you'll go, huh, she fell*; and undecided, reported contexts that were vague, ambiguous, habitual, or not specified – e.g., *That's what my mom keeps telling me.* Table 2 presents definitions and additional examples of reported speech types and temporal domains.

We also coded if the reported speech was the speech or thoughts of the speaker, including if the speaker was part of a group (self – e.g., *I said you really need to call 911; We talk about that at Curves every once in a while)* or another person (other – e.g., *They screamed for the boat to turn around and come back).* Finally, similar to the verbal productivity measure described above, we coded whether the reported speech was accurately produced or not (e.g., false starts, grammatical errors; e.g., *I told her well uh and vegetables you know*). Using a consensus process, each RSE was reviewed by the second and third authors to verify coding decisions and to eliminate RSEs from task instructions, non-explicit representations of speech and immediate, unframed repetitions of another's speech.

Results

Frequency of reported speech use

Across the data set, all participants used reported speech. Usage ranged from 27–77 reported speech episodes (RSEs) per session, with 652 RSEs identified across the 12 session. The vmPFC patients and the healthy comparisons produced nearly equivalent amounts, types, and forms of reported speech. The frequency of RSEs was similar between comparison participants ($M = 40.83$; SD = 22.82) and vmPFC participants ($M = 43.67$; SD = 10.88) with no significant group differences ($t(10) = 0.27$, $p = 0.79$). There were no significant differences in the frequency of reported speech use by the clinician when interacting with the comparison ($M = 9.8$; SD = 6.85) and vmPFC participants ($M = 14.33$; SD = 8.11; $t(10) = 1.04$, $p = 0.32$). The majority of RSEs across the data set were coded as accurately produced; however, accuracy was significantly higher in the comparison sessions ($M = 94.38\%$; SD = 10.53) than in vmPFC sessions ($M = 71.84\%$; SD = 14.64; $t(10) = 3.06$, $p = 0.01$).

Reported speech type and temporal domain

All five types of reported speech were observed across all sessions. Across all 12 sessions, direct (333/652; 51.07%) was the most frequently used type of reported speech, followed by indirect (150/652; 23.0%), indexed (97/652; 14.88%), projected (46/652; 7.06%) and unspecified (20/652; 3.07%). Using a two-tailed Wilcoxon matched pairs signed rank with Bonferroni correction for multiple comparisons ($\alpha = 0.01$) we found no significant group differences for reported speech type: direct RS ($Z = -0.27$, $p = 0.79$), indirect RS ($Z = -0.31$, $p = 0.75$), index RS ($Z = -0.63$, $p = 0.53$), projected RS ($Z = -0.21$, $p = 0.83$), and undecided RS ($Z = -0.73$, $p = 0.47$) (see Figure 2).

Across all sessions, all four temporal domains were represented with the majority of RSEs coded as past (399/652; 61.2%) followed by in-session (116/652; 17.8%), future (4/652; 0.01%) and unspecified (133/652; 20.4%). Using a two-tailed Wilcoxon matched pairs signed rank with Bonferroni correction for multiple comparisons ($\alpha = 0.0125$) we found no significant group differences in the distribution of the temporal domain of reported speech between the groups: past ($Z = -0.42$, $p = 0.67$), in-session ($Z = -0.63$, $p = 0.53$), future ($Z = -1.34$, $p = 0.18$), and unspecified ($Z = -2.21$, $p = 0.03$). The stringency of the Bonferroni correction increases the risk of Type 2 errors. It is worth noting that statistically significant group differences would have been observed for the unspecified temporal domain without the correction, suggesting that there may be group differences.

Distribution of reported speech across the session

Reported speech is an interactional discourse resource that can be employed to serve a variety of functions during speech. Across all sessions, the most reported speech episodes occurred during intertask talk (251/652; 38.5%), followed-by conversation (174/652; 26.7%), narrative (166/652; 25.5%), procedural (39/652; 6.0%), and picture description (19/652; 2.9%). Using a two-tailed Wilcoxon matched pairs signed rank test with Bonferroni correction for multiple comparisons ($\alpha = 0.01$) we found no significant group differences for the distribution of reported speech across the session: intertask ($Z = -0.94$, $p = 0.35$), conversation ($Z = 0.0$, $p = 1.00$), narrative ($Z = -0.11$, $p = 0.92$), picture description ($Z = -1.09$, $p = 0.28$), and procedural ($Z = -2.06$, $p = 0.04$). Note that without the correction there would have been a statistically significant group difference for the use of reported speech during the procedural tasks. The proportion of RSEs that coded as self or other were was also similar between comparison (42.0%, SD = 12.9%) and vmPFC participants (47.8%, SD = 11.0%) with no significant group differences ($t(11) = 0.56$, $p = 0.58$).

Discussion

In this study we sought to further examine the role of the vmPFC in social interaction and communication. Based on previous work documenting deficits in various aspects of social and emotional processing following vmPFC damage (Anderson *et al.*, 2006; Damasio, 1996; Mah *et al.*, 2005; Rolls, 1997; Stuss and Levine, 2002) and the implication that vmPFC is involved in the production of socially advantageous behaviors in conversation (Body, 2007; Schumann, 1999), we tested the hypothesis that vmPFC damage would disrupt the use of reported speech in conversation. Contrary to our hypothesis, participants with vmPFC damage did not differ from healthy comparison participants in

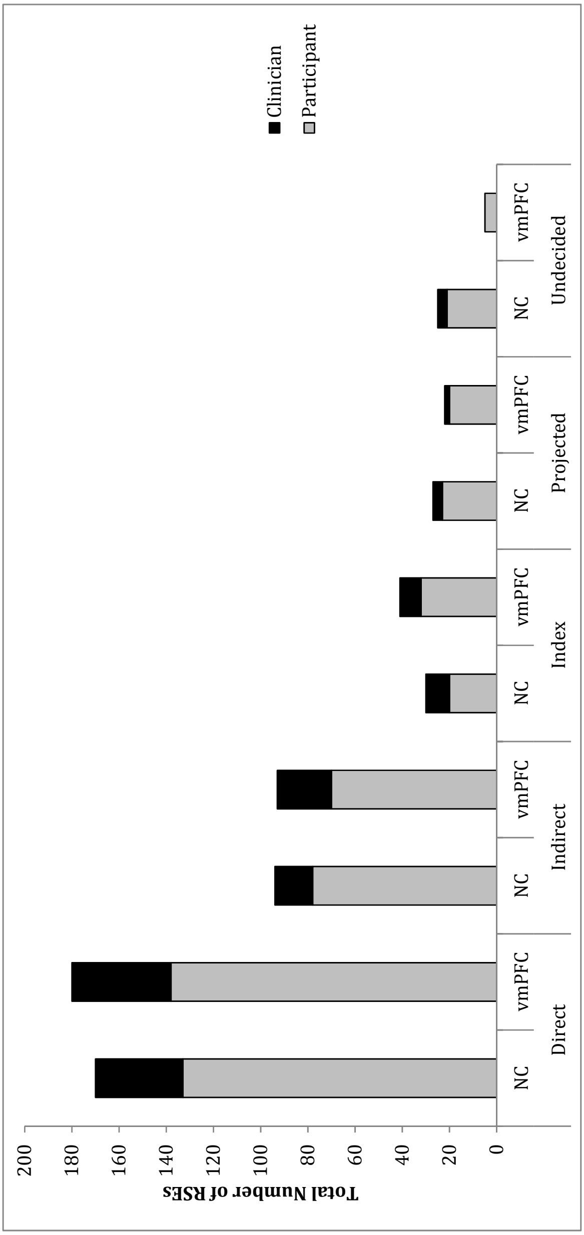

Figure 2. Total number of reported speech episodes (RSEs) by type and group. NC = normal comparison participants; vmPFC = ventromedial prefrontal cortex damaged participants; DRS = direct reported speech; IRS = indirect reported speech; PRS = projected reported speech; IDX = indexed reported speech; UD = undecided.

their use of reported speech in these interactive sessions. More specifically, the participants with vmPFC damage did not differ in the frequency, types, or temporal domains of reported speech use. These results suggest that the vmPFC may not be critical for the use of reported speech in social interaction, or at least not as elicited and measured here.

The vmPFC has been associated with social and emotional processing, as patients with damage to this area have difficulty empathizing with others (Beadle and Tranel, 2011; Eslinger, 1998; Shamay-Tsoory *et al.*, 2003), and in understanding the emotional expressions of others (Heberlein *et al.*, 2008; Hornak *et al.*, 2003; Tsuchida and Fellows, 2012). The finding that the vmPFC is not critical for reported speech use raises questions about the social and emotional contributions of reported speech in communication. Tannen (1989) argued that reported speech reflects and creates emotional connections (i.e., empathy) and interpersonal involvement between interlocutors. Yet, the individuals with profound deficits in social and emotional processing studied here, including disruptions in empathy and in their interpersonal relationships, did not differ from healthy comparison participants in their use of reported speech.

One interpretation of this seeming contradiction is methodological. It is possible that reported speech does place high demands on social and emotional processing but that our methods for eliciting these interactive sessions do not support the full range of interpersonal and social/emotional functions reported speech can serve. Indeed, capturing the social and emotional deficits in these patients with laboratory tasks can be challenging (see Gupta *et al.*, 2012). These patients have a wealth of preserved social knowledge which, coupled with intact intelligence and other cognitive abilities (including memory), allows them to perform normally in many settings much of the time (Anderson *et al.*, 2006; Saver and Damasio, 1991). That said, we wonder if the finding that vmPFC patients produce significantly more reported speech episodes that were coded as inaccurate or incomplete than healthy comparison participants (in the context of no group differences in overall reported speech frequency or verbal productivity across the sessions) suggests some degree of difficulty in the formulation or production of reported speech. Whether a different outcome would be obtained from examination of reported speech outside the laboratory, with specific conversational topics, with known communication partners, or other manipulations that increase social and affective demands, however, awaits further study.

Alternatively, it may be case that reported speech places higher demands on cognitive processes than on affective processes, and hence vmPFC patients, whose deficits are primarily affective, are not impaired. This dichotomy between cognitive and affective processing would fit with proposals in the literature suggesting that neuroanatomically distinct regions of the frontal lobes support distinct processing demands, with ventral aspects (i.e., vmPFC) critical for affective processing and dorsal aspects critical for cognitive processing (e.g., Shamay-Tsoory *et al.*, 2004; Stuss and Levine, 2002). This distinction between cognitive and affective processing has also been useful in understanding patterns of spared and impaired communicative abilities in our previous work with these same vmPFC participants. For example, we have reported *preserved* abilities in these vmPFC participants in aspects of language use that appear to have high cognitive demands (e.g., discourse cohesion, Kurczek and Duff, 2012) and *disruptions* in language use that appear to have high affective demands (e.g., conversational synchrony, Gordon *et al.*, 2014). It is worth noting that, consistent with this proposal, individuals with hippocampal amnesia (who have intact affective abilities and impaired memory) show the opposite patterns; amnesic patients are impaired at discourse cohesion (Kurczek and Duff, 2011) and intact at conversational synchrony (Gordon *et al.*, 2014). The finding here that vmPFC damage does not significantly disrupt reported speech use may suggest that reported speech place higher demands on cognitive processes than on affective processes.

Along these lines, the lack of impairment in the use of reported speech in the interactions of patients with vmPFC damage is particularly interesting compared to the striking deficits in reported speech we reported in individuals with hippocampal amnesia (Duff *et al.* 2007). In that study, we found that although individuals with hippocampal damage and profound deficits in declarative memory did not differ significantly from comparison participants in the types or forms of reported speech, the patients with amnesia produced only half as many reported speech episodes as comparison participants. Individuals with hippocampal amnesia were less likely to use reported speech even when representing memories from their remote past, for which their memory is considered intact. We have proposed that the hippocampal declarative memory system is well suited to meet the demands of reported speech (Duff *et al.*, 2007; Duff and Brown-Schmidt, 2012). Reported speech requires flexible access to a large temporal record of events as well as the ability to flexibly and creatively generate unique combinations of the elements of the representation (factual or hypothetical) to be reconstructed to meet specific interactional goals. The hippocampal declarative memory system supports the creation and integration of representations for events including information about the co-occurrences of people, places, and things, and the ability to link the spatial, temporal and interactional relations among them across time for both actual and imagined events (Eichenbaum and Cohen, 2001; Hassabis *et al.*, 2007). These previous finding from individuals with hippocampal amnesia taken together with the results of the current study suggest that while the vmPFC may not be a critical neural substrate for the successful use of reported speech in social interaction, the hippocampus is. These two results also support the notion that reported speech, as elicited and measured here, places particularly high demands on cognitive rather than affective processes. That said, it remains important for future studies to compare the methods used here with other protocols that may tap a more diverse range of affective and interpersonal uses of reported speech.

In summary, this study provides insight into the neural substrates of the use of reported speech and the role of the vmPFC in various aspects of communication and social interaction. We find the similar use of reported speech between individuals with vmPFC damage and healthy comparison participants surprising given the extensive literature documenting the critical role of the frontal lobes in social communication and the vmPFC in social interaction. Future studies could examine reported speech outside the laboratory and with routine communication partners in order to more fully characterize the role of vmPFC in reported speech and social and emotional aspects of communication.

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